

What is Claimed is:

1. A method comprising:

detecting a variation in resistance within a layered material stack in response to a scanning and injection of a non-contacting, remotely sourced electron stream into the layered material stack, the layered material stack having a first conductive contact layer, a second conductive contact layer, a variable resistive layer and a fixed resistive layer being positioned between the first and second conductive contact layers, and the variation in resistance within the layered material stack being based on one of a first resistive state and a second resistive state of the variable resistive layer;

generating a first magnetic field and a second magnetic field within a transformer in response to the variations in resistance from within the layered material stack when the electron stream is scanned across the layered material stack, the transformer being operatively coupled to the first and second conductive contact layers; and

generating a differential output signal within the transformer based on the first and second magnetic fields, the differential output signal being associated with one of the first and second resistive states of the variable resistive layer.

2. The method of claim 1, wherein detecting the variation in resistance within the layered material stack comprises detecting a difference in current distribution within the layered material stack in response to the scanning and injection of the electron stream into the layered material stack, the layered material stack having a substrate layer and wherein the second conductive contact layer is a portion of the substrate layer.

3. The method of claim 1, wherein detecting the variation in resistance within the layered material stack comprises:

detecting the first resistive state of the variable resistive layer in response to a distribution ratio of electrons from the electron stream flowing toward the first conductive
5 contact layer; and

detecting the second resistive state of the variable resistive layer in response to a distribution ratio of electrons from the electron stream flowing toward the second conductive contact layer.

10 4. The method of claim 3, comprising detecting a third resistive state of the variable resistive layer.

5. The method of claim 1, wherein generating the first and second magnetic fields within the transformer comprises generating a third magnetic field within the
15 transformer, the transformer having an identical number of turns.

6. The method of claim 1, wherein detecting the variation in resistance within the layered material stack comprises scanning and injecting the electron stream into the layered material stack, the layers of the layered material stack having layers of materials
20 that are significantly larger in area than the cross sectional area of the electron stream.

7. The method of claim 1, wherein generating the first magnetic field comprises passing a first current through a first wire that is operatively coupled to the first conductive contact layer;

and wherein generating the second magnetic field comprises passing a second
5 current through a second wire that is operatively coupled to the second conductive contact layer; and

wherein generating the differential output signal comprises positioning a sensor between the first and second wires to detect a vector sum of the first and second magnetic fields.

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8. The method of claim 1, wherein generating the first and second magnetic fields within the transformer comprises generating a net magnetic field within a center-tapped transformer.

15 9. The method of claim 1, wherein the layered material stack comprises the variable resistive layer underlying the first conductive contact layer, the fixed resistive layer underlying the variable resistive layer, and the second conductive contact layer underlying the fixed resistive layer.

20 10. The method of claim 1, wherein the layered material stack further comprises a third resistive layer located between the first and second conductive contact layers.

11. The method of claim 10, wherein the third resistive layer is a second
25 variable resistive layer.

12. The method of claim 1, comprising detecting a variation in resistance within the layered material stack in response to a scanning and injection of a non-contacting, remotely sourced electron stream into the layered material stack.

5 13. A transformer comprising:

a first winding operatively coupled to a first conductive contact layer of a material stack, the material stack also having a variable resistive layer, a fixed resistive layer, and a second conductive contact layer, the variable resistive layer and the fixed resistive layer being positioned between the first and second conductive contact layers, ;

10 a second winding operatively coupled to the second conductive contact layer, the first and second windings being configured in a differential configuration where a vector sum of a third magnetic field generated by the first and second windings is applied to a third winding such that a current difference between the first and second windings is detected and presented as an output of the third winding;

15 the first and second windings being configured to present opposing magnetic fields relative to each other when a current pulse of the same polarity is applied to a first input and a second input connected to the material stack, and

the third winding being configured to generate a proportional output signal resulting from a difference in current distributions in the material stack due to the
20 difference between a first resistive state and a second resistive state of the variable resistive layer resulting in a proportional response in the magnetic fields generated by the first and second windings based on the difference in current between the first and second conductive contact layers.

14. The transformer of claim 13, wherein the first and second windings
comprise an identical number of turns.

15. The transformer of claim 13, wherein the second conductive contact layer
5 is one of a substrate layer and a portion of the substrate layer.

16. The transformer of claim 13, wherein the first winding is configured to
detect the first resistive state of the variable resistive layer in response to a distribution of
electrons in an electron stream flowing toward the first conductive contact layer, and
10 wherein the second winding is configured to detect the second resistive state of the
variable resistive layer in response to a distribution of electrons in the electron stream
flowing toward the second conductive contact layer.

17. The transformer of claim 16, being capable of detecting a third resistive
15 state of the variable resistive layer.

18. The transformer of claim 13, wherein the layered material stack comprises
the variable resistive layer underlying the first conductive contact layer, the fixed resistive
layer underlying the variable resistive layer, and the second conductive contact layer
20 underlying the fixed resistive layer.

19. The transformer of claim 13, wherein the layered material stack further
comprises a third resistive layer located between the first and second conductive contact
layers.

20. A method comprising:

injecting a non-contacting, remotely sourced electron stream from an energy source into a material stack of data storage medium, the material stack having a first and second conductive contact layers, a variable resistive information storage layer and a fixed resistive layer being positioned between the first and second conductive contact layers, the variable resistive information storage layer having a different resistance to each of the first and second conductive layers, the electron stream engaging the variable resistive layer through the first conductive contact layer, and the variable resistive layer having a plurality of resistive states;

detecting a difference in current distributed to the first and second conductive contact layers via a sensor in response to the injection of the electron stream into the material stack, the sensor having a first winding operatively coupled to the first conductive contact layer and a second winding operatively coupled to the second conductive contact layer, the sensor configured to generate an output signal proportional to the difference in the plurality of resistive states of the variable resistive layer, based on the difference in current between the first and second conductive contact layers.

21. The method of claim 20, wherein injecting the electron stream into the material stack comprises injecting the electron stream into the material stack having a substrate layer, and wherein the second conductive contact layer is a portion of the substrate layer.

22. The method of claim 20, wherein detecting the difference in current distributed to the first and second conductive contact layers via the sensor comprises:

detecting a first resistive state of the variable resistive layer in response to a distribution of electrons of the electron stream flowing toward the first conductive contact layer; and

detecting a second resistive state of the variable resistive layer in response to a distribution of electrons of the electron stream flowing toward the second conductive contact layer.

23. The method of claim 20, wherein the layered material stack comprises the variable resistive layer underlying the first conductive contact layer, the fixed resistive layer underlying the variable resistive layer, and the second conductive contact layer underlying the fixed resistive layer.

24. The method of claim 20, wherein the layered material stack comprises the fixed resistive layer underlying the first conductive contact layer, the variable resistive layer underlying the fixed resistive layer, and the second conductive contact layer underlying the variable resistive layer.

25. The method of claim 20, wherein the layered material stack further comprises a third resistive layer located between the first and second conductive contact layers.

26. The method of claim 20, wherein the sensor is a magneto-resistive sensor.

27. The method of claim 20, wherein the sensor is a transformer and further comprises a third winding to generate the output signal.

28. The method of claim 27, wherein detecting the difference in current
5 distributed to the material stack comprises detecting the difference in current distributed to the material stack via a transformer having a first winding and a second winding with an identical number of turns relative to each other.

29. A system comprising:

an energy source configured to inject a non-contacting, remote electron stream into a material stack of a data storage medium, the material stack having a first and second conductive contact layers, a variable resistive information storage layer and one or more fixed resistive layers, the variable resistive information storage layer and the one or more fixed resistive layers being positioned between the first and second conductive contact layers, the variable resistive information storage layer having a different fixed resistance to each of the first and second conductive contact layers, and the electron stream engaging the variable resistive layer through the first conductive contact layer;

10 a power supply configured to provide an anode voltage to the first and second conductive contact layers of the material stack; and

a transformer having a first winding operatively coupled to the first conductive contact layer to provide the anode voltage from the power supply to the first conductive contact layer, a second winding operatively coupled to the second conductive contact layer to provide the anode voltage from the power supply to the second conductive contact layer, and a third winding configured to output a signal associated with one of a first resistive state and a second resistive state of the variable resistive layer in response to the difference between a first magnetic field and a second magnetic field generated by the first and second windings, the first and second windings being in a differential configuration relative to each other to generate the first and second magnetic fields based on a difference in current, and to detect a difference in current between the first and second conductive contact layers in response to the injection and distribution of the electron stream into the material stack.

30. The system of claim 29, wherein the first and second windings comprise an identical number of turns.

31. The system of claim 29, wherein the second conductive contact layer is
5 one of a substrate layer and a portion of the substrate layer.

32. The system of claim 29, wherein the transformer is configured to detect the first resistive state of the variable resistive information storage layer in response to a distribution of electrons of the electron stream flowing toward the first conductive contact
10 layer and to detect the second resistive state of the variable resistive information storage layer in response to a distribution of electrons of the electron stream flowing toward the second conductive contact layer.

33. The system of claim 29, comprising configuring the third winding to
15 output another signal associated with a third resistive state of the variable resistive information storage layer.

34. The method of claim 29, wherein the material stack comprises one of the one or more fixed resistive layers underlying the first conductive contact layer, the
20 variable resistive information storage layer underlying the one or more fixed resistive layers, and the second conductive contact layer underlying the variable resistive information storage layer.

35. The method of claim 29, wherein the material stack comprises two fixed
25 resistive layers located between the first and second conductive contact layers.

36. A method comprising:

detecting a number of variations in resistance within a layered material stack in response to a scanning and injection of an electron stream into the layered material stack, the layered material stack having a first conductive contact layer, a fixed resistive layer
5 underlying the first conductive contact layer, a variable resistive layer underlying the fixed resistive layer, and a substrate layer underlying the variable resistive layer, and the number of variations in resistance within the layered material stack being based on at least one of a first resistive state and a second resistive state of the variable resistive layer;

generating a first magnetic field and a second magnetic field within a transformer
10 in response to the number of variations in resistance from within the layered material stack when the electron stream is scanned across the layered material stack, the transformer being operatively coupled to the first conductive contact layer and the substrate layer; and

generating a differential output signal within the transformer based on a vector
15 sum of the first and second magnetic fields, the differential output signal being associated with one of a number of resistive states of the variable resistive layer.

37. The method of claim 36, wherein detecting the number of variations in resistance within the layered material stack comprises:

20 detecting a first resistive state of the variable resistive layer in response to a distribution ratio of electrons from the electron stream flowing toward the first conductive contact layer; and

detecting a second resistive state of the variable resistive layer in response to a distribution ratio of electrons from the electron stream flowing toward the substrate layer.

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38. The method of claim 36, wherein detecting the number of variations in resistance within the layered material stack comprises scanning and injecting the electron stream into the layered material stack, the layers of the layered material stack having layers of materials that are significantly larger in area than the cross sectional area of the
- 5 electron stream.